EARLY GROWTH RESPONSE OF *MERANTI* SEEDLINGS TO THEIR COMPANION CROPS GROWN UNDER AGROFORESTRY SYSTEM*)

by:

Moh. Sambas Sabarnurdin**)

ABSTRAK

Untuk mengamati pengaruh tanaman semusim, tiga spesies dipterokarpus, yaitu meranti putih (*Shorea macroptera),* meranti merah (*S. acuminatissima),* dan meranti sapat (*Shorea spp.)* ditanam bersama sama kacang tanah, jagung dan ketela pohon mengikuti pola tanam *agroforestry.*

Sebanyak 36 Petak percobaan berukuran 10m x 24 m., diatur dalam 3 blok mengkuti Pola Acak Lengkap. Percobaan ini dilakukan pada lahan bekas hutan sekunder yang dipersiapkan secara manual.

Hasil penelitian menunjukkan bahwa dalam enam bulan pertama sejak ditanam, tanaman semusim tidak menunjukkan pengaruh nyata pada semai-semai meranti, kecuali terhadap meranti sapat. Namun sebaliknya 12 bulan kemudian, pengamatani menunjukkan bahwa tanaman semusim secara nyata mempengaruhi pertumbuhan meranti kecuali meranti sapat. Meskipun tanggapan pertumbuhan meranti terhadap tanaman semusim itu amat beragam, diperoleh fakta bahwa ketela pohon berada dalam deretan pertama jenis tanaman-peserta yang berpengaruh positif, baru kemudian diiikuti oleh jagung dan kacang tanah. Selanjutnya dibuktikan bahwa sampai enam bulan setelah penanaman, tidak terlihat adanya perubahan pada status kesuburan tanah.

Keyword: agroforestry, agrisilviculture, shorea, tree-companion crops,

INTRODUCTION

Agroforestry as a land management system seems suitable to be practiced on ecologically fragile areas since it combines the protective (and also productive) characteristics of forestry with the productive attributes of agriculture (King, 1979). Despite its new term, the system has long been practiced by farmers on their lands.

---

* Research funded by KEEC-UGM cooperation: part of it had been shown in poster session in FORTROP seminar at Kasetsart University Bangkok, 1996

** Faculty of Forestry, GMU, Yogyakarta

The agroforestry practice on forest lands known as *tumpangsari* (the Indonesian term for Taung-ya, carried out during the 2 to 3 years- "agricultural stage" of the teak life cycle, was introduced in 1883 by Buurman (Kartasubrata,1979). During the *tumpangsari* period farmers are permitted to grow their crops between rows of trees on the condition that they have to tend the trees. The principal motive of a taungya system, which a reduction in the cost of stand establishment by "exploiting" people's poverty as mentioned by Contant (1979), has changed. There is an ongoing tendency to get into more fair-cooperation between both the forest service or foresters and farmers leading to the improvement of the system itself. (Sabarnurdin, 1988). The improvement of the system needs more attention on the ecological basis of the practice (Atmosoedaryo and Barnyard, 1979). Results of former studies showed that peanut was the most harmful companion crops for teak (Sabarnurdin,1988), as well as for *Acacia mangium*, *sungkai* (*Peronema canescens*), *Eucalyptus deglupta*, and *sengon* (*Paraserianthes falcataria*).

The present study was carried out in responsee to the problems mentioned above to add some information on the interference between *meranti* and crops grown with it. More specifically, the main objective of the study was to document the effects of inter-planted crops, and assess changes in nutrient status of the soil. Result of this study might be important for making recommendation on: 1) the companion crop to be grown with *meranti*, and 2) the agrisilviculture cropping pattern suitable to the area.

MATERIALS AND METHODS

Site Description

The study was conducted in the Silva Gama Forest Experiment area, located 250 km. northwest of Jambi (± 100 m above sea level). It has a type-A climate of Schmidt and Ferguson Classification, the average rainfall is 2266 mm/year and daily temperature ranges from 21.1 – 33.4^{O}C. Soil is detected as Red podzolic, clay, poor and acidic, low pH, high organic content in its surface, moderate level of total N, low CEC, low available-P, and low available K. The chemical status of soil sample taken from 0-20 cm depth is shown in Table 1 below .

Plantation Establishment

The trial plot was established in the Silva Gama Forest area using *sapat meranti* (*Shorea lepidota*), Red *meranti* (*S. parvifolia*), and white *meranti* (*S. macroptera*) and crops of peanuts (*Arachis hypogea*), maize (*Zea mays*), and cassava (*Manihot esculenta*).

The experimental plots were established on a manually prepared land area formerly covered by secondary forest, arranged in 3 blocks using a Randomized Complete Block Design (RCBD). Each of the total of 36 Shorea tree-crop combina

Table 1. Soil chemical status before treatment

Soil Properties	Unit	Value
.pH (H2O)		3.48
Organic matter	%	6.88
Total N	%	0.20
Total P	ppm	11.21
Available K	me/100 gr	0.30
Available P	ppm	4.06
CEC	me/100 gr	8.58

tion plots of 10 x 24 m. square were planted in each plot following a rectangular arrangement, 2 m by 3 m in spacing. Maize was planted trees to four seeds per hill at 50 x 50 cm spacing and reduced to only two plants per hill. Peanuts were planted at 25 cm x 25 cm spacing, while cassava at 1 m x 1 m. Trees grown without crops were actually opened to weed interference. Under the *tumpangsari* system, the weed competition was periodically controlled by farmers as they weed for their crops; however, for non-*tumpangsari* plots, weeding were carried out by using patch weeding technique where a 25 cm circle of the ground surrounding each tree was cleaned.

Parameters Measured

At the time of establishment, each seedlings diameter and height were measured. Soil samples were analyzed to provide basis for monitoring. Six months later, re-measurement of tree growth and soil samples was done.

Tree Growth Parameters

Measurement was carried out on 21 trees of the middle rows of each plot. Height was measured from the soil surface to the end of an opened young leaf using a measuring pole. Stem diameter was measured at the soil surface using a caliper.

Crop Parameter

A three 1 x 1 m square plots were randomly established within each experimental plot. The crops were harvested from each plot and sundried for a week following the local practice. The un-husked dried rice, grained maize and peanut seeds

were then weighed. The moisture content of seeds was measured using a seed-bury digital moisture meter. These values of seed moisture contents represented the 'moisture content at harvest time' for further yield calculation. The yield of crop per hectare was calculated following a formula of Zandstra et al. (1981).

Soil Nutrient Status

Soil samples were taken from 0-20 cm depth at the beginning of the trial and retaken 6 months after planting. Soils were analyzed for total N and total P using the semi micro Kjehldal technique; pH using a glass electrode assembly, and organic carbon according to the Walkey-Black (Potassium dichromate) method.

RESULTS AND DISCUSSION

Response of *Meranti* Seedlings

The effects of agroforestry on *meranti* were examined during its first six-month period of growth (at the end of the first agricultural cropping season), and at 12 months. At the end of the first agricultural cropping season the height of *meranti* seedlings ranged from 7.72 cm (*sapat meranti* grown with peanuts) to 17.29 cm (white *meranti* control), while at 12 months after planting it ranged from 42.60 cm (white *meranti* grown with maize) to 92.80 cm. (red *meranti* grown with cassava) while the diameter ranged from 1.87 cm (red *meranti* control) to 3.11 cm (red *meranti* grown with cassava), and from 4.58 cm (*sapat meranti* grown with maize) to 7.13 cm (white *meranti* grown with cassava) , at 6 months and 12 months after planting respectively. (Table 2).

Most of the *meranti* parameters depicted in Table 2 were not significantly affected at the first measurement, but significantly affected after 12 months. (Table 3). The exception was observed on *sapat meranti*. Its height growth was significantly affected at the first 6, but then it was shown not affected by the existence of crops after 12 months. Based on the average growth observed 12 months after plant establishment (depicted in Table 4), it was found that:

1) *Sapat meranti* was not influenced by any of the companion crops. It has shown as producing the tallest seedling (81.24cm), followed by red *meranti* (74.92 cm) and white *meranti* (43.98 cm). However, in terms of diameter, their growth tends to be equivalent with others.

2) Red *meranti* was influenced by crops. All crops showed significant influence on red *meranti* height growth compared with control (subject to weed competition). The order of non harmffulness was cassava > maize > peanuts > weeds.

3) The height growth of White *meranti* was behind to other *merantis*. However, as far as cassava is concerned, White *meranti* shows almost similar response

Table 2 Average height and diameter of dipterocarps planted with crop at 6 and 12 months after planting.

Trees	Crops	Diameter (mm)		Height (cm)	
		6 mos.	12 mos.	6 mos.	12 mos.
Red *meranti*	Control	1.87	6.35	17.16	51.50
	Peanuts	2.26	6.13	15.44	72.93
	Maize	2.05	4.83	13.33	82.57
	Cassava	3.11	4.74	12.62	92.80
White *meranti*	Control	1.94	5.36	17.29	34.90
	Peanuts	2.37	5.47	7.90	45.90
	Maize	2.59	6.51	14.41	42.60
	Cassava	2.23	7.13	10.27	52.83
Sapat meranti	Control	2.33	5.87	12.55	92.33
	Peanuts	2.12	5.00	7.72	69.43
	Maize	2.37	4.58	14.45	83.53
	Cassava	2.10	6.87	10.54	79.70

Table 3. Calculated probability of crop influence on *meranti* seedlings

Seedling Species	Parameter measured	Calculated Probability at	
		6 months	12 months
Red *meranti*	Diameter	0.102 ns	0.025 **
	Height	0.368 ns	0.001 **
White *meranti*	Diameter	0.092 ns	0.017 **
	Height	0.164 ns	0.003 **
Sapat meranti	Diameter	0.103 ns	0.113 ns
	Height	0.028 *	0.213 ns

to crops as red *meranti*. The order was cassava > peanuts > maize > weeds. The mean comparison showed that the effect of cassava was significantly different compared with that of maize, except peanuts; and there was no significant difference between the effect of maize and that of weeds (control).

Response of Soil Nutrient Status

The chemical properties of the soil of the experimental site at the beginning of the study was shown in column 2 of the following Table 5. Up to 6 months after planting, there was no big changes in soil nutrient status. Data for 12 months was not

Table 4. Comparison of Average diameter and height of *meranti* as influenced by companion crops, 12 months after planting

Crops	Trees					
	Red *Meranti*		White *meranti*		*Sapat meranti*	
	Diameter	Height	Diameter	Height	Diameter	Height
Control	6.35 a	51.50 a	5.36 a	34.90 a	5.87 a	92.33 a
Peanuts	6.13 a	72.90 b	5.47 a	45.90 b	5.00 a	69.43 a
Maize	4.63 b	82.57 c	6.51 b	42.60 a	4.58 a	83.53 a
Cassava	4.74 b	92.80 d	7.13 b	52.83 c	6.87 a	79.70 a
Average	5.46	74.92	6.11	43.98	5.58	81.24
	0.78	5.96	0.72	5.21	Crops is "ns" (Table 2), no mean comparison needed.	

available due to technical failure. However the writer experience on teak in Java (Sabarnurdin, 1988) and on some fast growing species in South Kalimantan (Sabarnurdin and Ariani, 1992), and also Ojeniyi and Agbede (1980) in Africa showed no significant changes in Nitrogen, Phosporus, and Soil total exchangeable bases as a result of agrisilviculture practice.

Table 5. Soil nutrient status of soil at the beginning (control) and after 6 months of planting

Soil properties	Contr	Tree-crop combination								
		MZ	MPe	MC	PM	Ppe	PC	SZ	SPe	SC
.pH	3.48	3.58	3.51	3.49	3.52	3.56	3.46	3.52	3.56	3.45
N-total (%)	0.20	0.21	0.22	0.23	0.21	0.20	0.18	0.20	0.22	0.23
K-total (%)	0.018	0.02	0.015	0.016	0.013	0.01	0.018	0.013	0.018	0.014
Avail K (ppm)	0.3	0.39	0.425	0.046	0.434	0.377	0.393	0.387	0.401	0.042
Avail P (ppm)	4.06	4.23	4.56	5.16	4.85	4.23	4.85	4.25	4.13	4.18
CEC me/100 gr	8.58	18.18	17.25	20.32	18.41	13.40	16.91	19.12	17.36	16.77
Org. matter (%)	6.88	7.58	7.62	7.23	7.33	8.23	8.12	8.35	8.08	8.26

Note: M= red *meranti*, P = white *meranti* , S= *sapat meranti*, Z= maize, Pe= peanut, C=cassava.

Crop Yields

The yields of crops were observed on the plot basis, as it was intended to measure the crop yield per ha. The crops was measured at two harvest time during 12 months, while cassava yield was obtained from 1 harvest time only.

The yield of crops were as follows: Maize, ranged from 758 kg/ha to 934 kg/ha; peanuts ranged from 680 kg/ha to 980 kg/ha, and cassava ranged from 10,682.5 ton – 13,168.4 ton/ha; and weeds ranged from 3.5 ton to 4.5 ton/ha (Table 6). Weeds meaning a mixture of all weeds existing in the control plot (pure planted *meranti*), was also harvested and measured. Table 5 also showed the magnitude of weed fresh biomass that should be considered when we thought about tedious weeding jobs that should be carried out regularly. This was another consideration for selecting agroforestry system in tree-stand establishment projects.

The low yield of crops was a "normal" yield of crops of this kind of waste land which has been encroached by people for long time, where no inorganic commercial fertilizers were applied. The experiment was also intended to providing a "base line" data for further improvement of the present and similar traditional way of farming.

Table 6. Average crop yields per ha. of each tree– crop combination at 12 months (cassava data was From one harvest, while other crops twice).

Tree species	Crop yield (kg)/ha			
	maize	peanut	Cassava	Weeds
Red *Meranti*	876.5	679.7	12,357.7	4457
White *Meranti*	934.5	755.8	13,168.4	3462
Sapat Meranti	758.8	979.1	10,692.5	4435

CONCLUSION

1. For the first six months after planting, crops showed no significant influence on the growth parameters of *meranti*, except *sapat meranti*.
2. After 12 months, crops did show a significant effect on height growth of red *meranti* and white *meranti* seedlings, but not on *sapat meranti*. The order of height of seedlings is *sapat meranti*> red *meranti*> white *meranti*.
3. The order of unharmfulness of companion crops, depends on the corresponding *meranti*,which is as follows:

- Although crops had no significant effect on the growth of *sapat meranti*, indicating that there was no difference among the companion crops, the order was maize> cassava> peanuts > weeds.
- For red *meranti*, the order was cassava > maize.= peanuts> weeds.
- For white *meranti*, the order was cassava > peanut >maize =weeds

4. In terms of soil status, up to six months after planting there was not much changes in the soil chemical properties, although some properties tend to increase.

REFERENCES

Atmosoedaryo, Soekiman and S.G. Barnyard, 1979. The prosperity approach to forest community development in Java. Comm. For. Rev. 57 (2): 89-96.

Contant, R.B., 1979. Training and Education in Agroforestry . In Chandler, T. and David Spurgeon (ed.) Proceeding of an International Conference in Agroforestry. ICRAF, Nairobi. Kenya, p: 220-229

Kartasubrata, Y., 1978. *Tumpangsari* method for establisshment of teak plantation in Java. In Proceeding of a Symposium on Tropical Agricultural Technologies, Tsukuba, Japan. Tropical Agricultural Series 12: 141-152

King, K.F.S., 1979. Concept of Agroforestry. In Chandler, T. and David Spurgeon (ed.) Proceeding of an International Conference in Agroforestry. ICRAF, Nairobi. Kenya, p: 1-14.

Ojeniyi, S.O. and O.O. Agbede. 1980. Effects of single crop agrisilviculture on soil analysis. Expl. Agri. 16: 371-375.

Sabarnurdin, M. S., 1988. Effects of Agroforestry Practice on Growth of Teak, Crop Production and Soil Fertility. MSU Dissertation, unpublished.

———, and Riswan Ariani, 1991 Effects of Agroforestry Practice on Growth of some Fast Growing Species, Crop Production and Soil Chemical Status. In Sabarnurdin,S; Heru Iswantoro, and Goran Adjers (ed.), Proceeding of Seminar in "Reforestation on Alang alang grass land area : Experience from South Kalimantan." Fakultas Kehutanan UGM and ATA 267 Project.

Zandstra, H.G., E.C. Price, J.A. Litsinger, and R. Morris, 1981. A methodology for On-farm Cropping System Research, IRRI, Philippines.